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STUDIES OF THE LIFE HISTORIES OF SOME QUEENSLAND BLATTIDAE (ORTHOPTERA).

Part 1. The Domestic Species.

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(With 9 Text-figures.)

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INTRODUCTION.

Interest in Blattidae was aroused by finding two species naturally infected with Salmonella during an epidemic of gastro-enteritis in Brisbane in 1947 (Mackerras and Mackerras, 1948), and subsequently demonstrating that artificially infected cockroaches might remain carriers for six weeks (Mackerras and Pope, 1948). It was then realised that, although many studies of domestic blattids have been made in other parts of the world, we could find no comprehensive account of any species in Australia. Answers to the questions " How long do egg-capsules take to hatch ? ", and " How long may adults live ? " were necessary in planning a campaign of control.

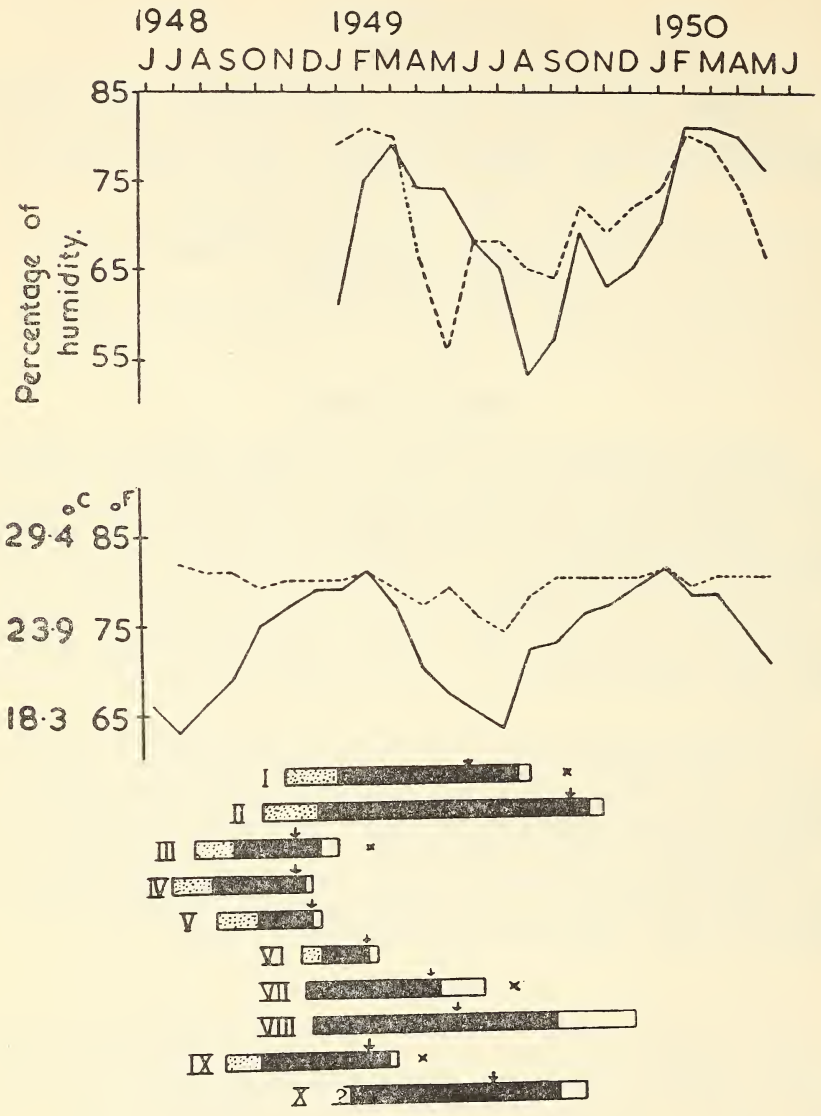
Descriptions of the domestic species are scattered through the literature and are not always readily obtained. Brief systematic descriptions, together with figures, are therefore included to enable those interested to identify the various species at any stage. An account of the life history of each species is given. While many records of the life histories of *Periplaneta americana*, *Blattella germanica* and *Supella supellectilium* have been published, references to *P. australasiae* and *Nauphoeta cinerea* are relatively scanty. None was found concerning *P. ignota*.

METHODS.

Most of the domestic cockroaches were easy to breed in laboratory colonies. Some colonies were kept at room temperature and others in a heated cupboard maintaining a temperature ranging from 73° to 84°F. (22·8°–28·9°C). The graphs (text-fig. 1) show the monthly means of the percentage of humidity and the temperatures in the cupboard and the room.

Egg-capsules were isolated as soon as they were found and all nymphs hatching from one egg-capsule were set up as a colony. Notes were made on the incubation period, the duration of nymphal period, the appearance of the first adult of each sex, the first egg-capsule produced and the total length of life. In addition single females were isolated with one or more males to obtain information about their egg-laying capacity.

The cockroach colonies were usually set up in dressing jars, measuring 6″ x 6″, and several layers of muslin were used as covers for the tops. The bottom of the jar was covered with sterile sand ; pieces of bark and filter paper gave extra surface area. Water was supplied in small dressing



Text–fig. 1. Above. Four graphs showing the monthly means of the percentage of humidity (at 9 a.m.) and the temperature of the heated cupboard (broken line), the room (full line). Below. A diagram of the egg-to-egg cycles of domestic species of Blattidae.

Stippled area	.. ..	Egg incubation period.
Black area	.. ..	Hatching to first female adult in a colony. (Appearance of first male marked by an arrow).
Blank area	.. ..	Preoviposition period.
X	.. .. ..	Marks colonies kept in the heated cupboard.

I.–II. *P. australasiae,* III.–VI. *B. germanica,* VII.–VIII. *N. cinerea,* IX.–X. *S. supellectilium.*

jars, 1″ x 2″, filled with wet cotton wool. Food consisted of a mixture of dried milk, dried yeast, and cracked corn or wheat. Cake, "Farex," bran and fresh apple were also given from time to time.

At first ether was used as an anaesthetic when it was necessary to sex adults, or to transfer a colony to a clean jar. Later carbon dioxide was used and found more satisfactory.

It was very difficult to maintain the right humidity for egg-capsules during incubation. When the humidity was low, they tended to dry out and when it was high, they became mouldy. The best results were obtained by isolating them in sterile test tubes tightly stoppered with cotton wool.

Descriptions have been taken from live insects, since pinned specimens frequently become greasy and the distinctive patterns lost. In all species variations in colour intensity are commonly seen.

A. DOMESTIC SPECIES OF PERIPLANETA.

The genus *Periplaneta* Burmeister (subfamily Blattinae) is represented in Brisbane by three domestic species, *australasiae*, *americana* and *ignota*. As far as I have been able to observe *australasiae* is more usual in dwellings and *americana* in sewers and manholes. The most uncommon is *ignota*.

Their fully developed wings enable them to fly easily into houses on summer nights and they can run very fast. They are particularly averse to daylight, and in three years observation not once were any Periplanetas seen mating in laboratory colonies. These species always ate their own exuviae and dead, and very often their own egg capsules.

Adults of these domestic species are large, brown cockroaches, usually about one to one and a half inches long and having the following characters in common. Light brown head with darker vertex, white ocelliform spots, interocular width less than interantennal, long dark brown antennae, yellowish-brown legs with brown spines, posterior metatarsus longer than the other tarsal segments combined, small pulvilli, arolia present, anterior part of wing yellowish-brown, anal area colourless with brown veins, brown cerci considerably exceeding the supra-anal lamina. The male subgenital plate bears a pair of unsegmented styles, and that of the female is modified to a bivalvular structure (Text–fig. 3j).

The larger nymphs resemble the adults in general conformation. Styles are present in nymphs of both sexes until the final moult when the female loses them.

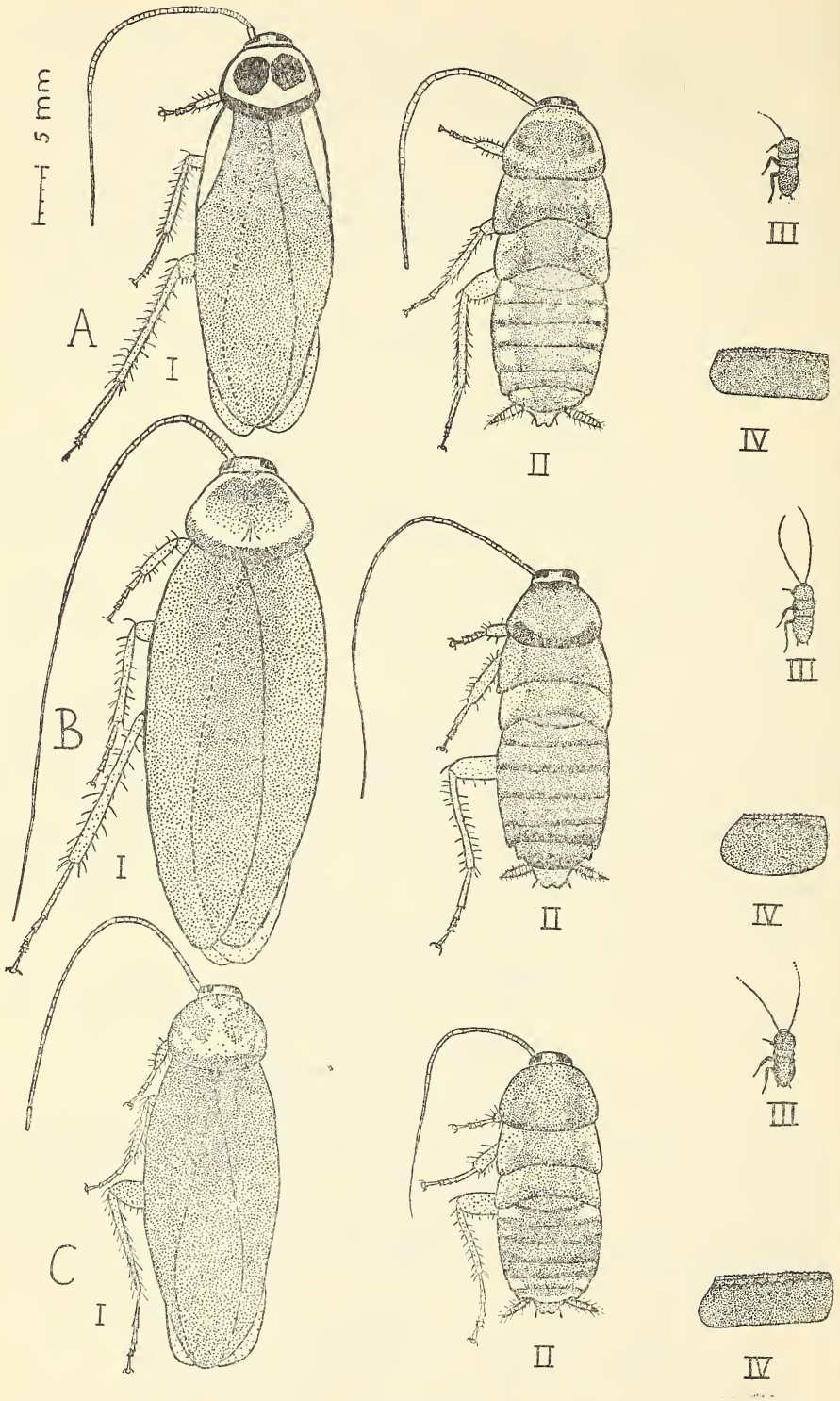
1. PERIPLANETA AUSTRALASIAE (Fabricius, 1775).

(*a*) Description of Stages.

ADULT (Text–fig. 2 AI). Pale yellow pronotum with dark brown margins (considerably wider posteriorly than anteriorly), and with two very dark brown maculae (often fused). Brown tegmina with yellow humeral streaks. Yellowish-brown abdominal tergites and sternites, darkening considerably towards margins and also apex of abdomen ; 7th tergite backwardly produced. Dark brown cerci. The genital plates are shown in text–fig. 3.

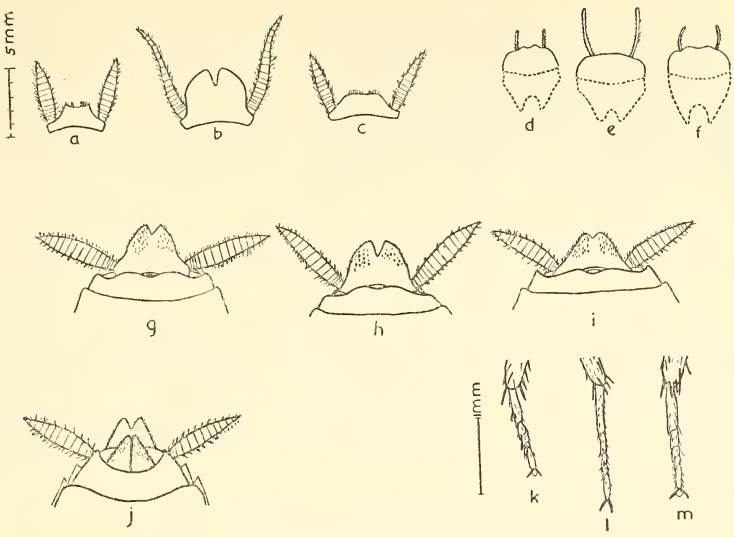
Total length* :	♂ 26–35 mm., ♀ 30–35 mm.
Tegmina length :	♂ 23–28 mm., ♀ 22–25 mm.
Pronotum width :	♂ 8–9 mm., ♀ 9–11 mm.

* The total length was measured from the vertex to the tip of the supra-anal plate.



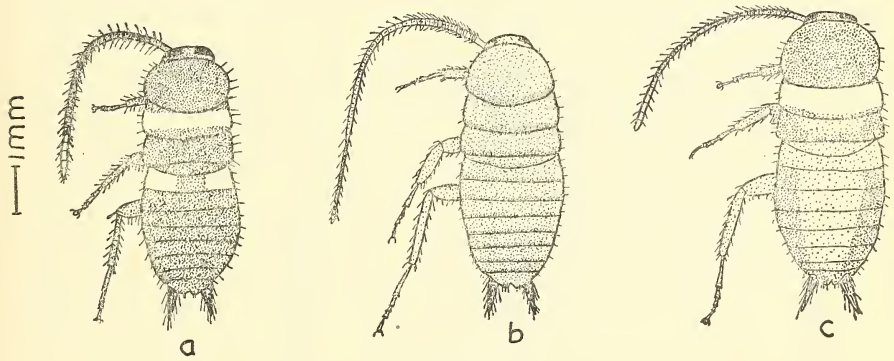
TEXT-FIG. 2.

A. *P. australasiae*; B. *P. americana*; C. *P. ignota*; I. male adult; II. large nymph; III. newly hatched nymph; IV. egg capsule.



TEXT–FIG. 3.

Male supra-anal plate: a, *australasiae;* b, *americana;* c, *ignota.* Male subgenital plate: d, *australasiae;* e, *americana;* f, *ignota.* Dorsal view of tip of abdomen of female: g, *australasiae;* h, *americana;* i, *ignota.* Ventral view of tip of female abdomen: j, typical *Periplaneta.* Posterior tarsi of newly hatched nymphs: k, *australasiae;* l, *americana;* m, *ignota.*



TEXT–FIG. 4.

Newly hatched nymphs (mounted specimens). a, *australasiae*; b, *americana;* c, *ignota.*

LARGE NYMPH (Text–fig. 2 AII). May be distinguished by the following characters:—yellow pronotum with dark margins, considerably wider posteriorly than anteriorly and with two large, dark brown maculae and a brown median smudge which extends to the tip of the abdomen. Mesonotum and metanotum yellowish, with dark brown posterior margins and with translucent wing pads developing in the larger nymphs. Abdominal tergites brown medially, with pale spots ringed with darker brown laterally on second to fifth and on seventh segments. Sternites yellowish-brown. Arolia present.

NEWLY HATCHED NYMPH (Text–figs. 2 AIII and 4a). Head dark, basal segments of antennae pale, four or five apical segments white, remainder black. Dorsal surface dark brown to black with a white band on mesonotum and another on the second abdominal tergite. The latter is interrupted by a median black mark. Legs dark brown, tarsi pale. Arolia present (Text–fig. 3k). Total length, 4–4·5 mm.; antennae length, 4·5 mm.

EGG–CAPSULE (Text–fig. 2 AIV). Dark brown, containing 24–26 eggs side by side in 2 parallel rows. Length, 10–11 mm.; depth, 5 mm.

(*b*) LIFE HISTORY.

(i.) INCUBATION PERIOD. Egg–capsules deposited from October to February (i.e. during summer) hatched in 7 to 8 weeks, those laid in March in 11 to 13 weeks, in April (one record) 23 weeks, in August about 10 weeks and in September 8 to 9 weeks. We have no records of egg-capsules laid during May to July. Those incubated in the warmed cupboard hatched on the average in 53 days.

(ii.) DURATION OF NYMPHAL DEVELOPMENT. There was very great variation in the rate of nymphal development. Although exposed to the same climatic conditions, and having abundant supply of food, a lag of from one to nine months was observed between the appearance of the first and last adult in nymphs derived from a single egg-capsule. At room temperature in summer the shortest period was 156 days for a male and 170 days for a female. There was almost invariably a considerable loss by death between hatching and reaching adulthood, but this could not be calculated at all accurately as dead nymphs (and exuviae) were almost always eaten. Table I. gives the information obtained from some colonies of *P. australasiae*.

TABLE I.

DURATION OF NYMPHAL DEVELOPMENT IN P. AUSTRALASIAE.

Colony Number.	Site.	Date of Hatching.	Period (in Days) from Hatching to Appearance of Adult.		
			Male.	Female.	Final.
200	Room	16 Feb.	316	338	—
2	,, ...	31 Mar.	310	330	596
50	,, ...	21 Sept.	156	170	374
106	,, ...	25 Nov.	309	335	410
110	,, ...	26 Nov.	308	334	381
58	,, ...	1 Dec.	286	337	337
143	,, ...	15 Dec.	268	301	342
17	Cupboard ..	26 May	195	239	285
30	,, ...	21 July	184	223	236
68	,, ...	19 Oct.	140	167	172
97	,, ...	9 Nov.	134	192	272
151	,, ...	29 Dec.	142	198	373

(iii.) EGG-LAYING CAPACITY. At room temperature females produced their first egg-capsule 15 to 48 days after their final moult, adult males being already present in the colony. The average period observed was 21 days. In the warmed cupboard the range was 11 to 24 days, average 16 days. The minimum interval between ovipositions was 2 days and the maximum 40 days. The productivity of some individual females is set out in Table II.

TABLE II.

THE EGG-LAYING CAPACITY OF SOME P. AUSTRALASIAE FEMALES.

Colony Number.	Site.	Total Number of Egg-Capsules Produced.	Reproductive Period (Days).	Average Interval between Ovipositions (Days).
260	Room	31	251	8
H	,, ...	17	109	7
N	,, ...	20	119	6
Average	,, ...	23	160	7
68A	Cupboard	17	136	9
141	,, ...	31	154	5
267	,, ...	15	108	8
I	,, ...	29	175	7
K	,, ...	29	164	6
Average	,, ...	24	147	7

The reproductive period referred to in Table II. is the interval between the deposition of the first and last egg capsule by a female. In the laboratory colonies the last few egg-capsules produced by a female, before she died, seldom hatched and usually were smaller than the earlier ones.

In the laboratory colonies, *australasiae* females always endeavoured to conceal their egg-capsules with sand particles, or minute pieces of filter paper securely glued in place by a secretion from the mouth. Three days was the longest time a female was seen carrying an egg capsule. The usual time taken to produce and deposit one was 24 hours. It is produced and carried with the serrated ridge dorsally.

Roughly the egg-to-egg cycle of *australasiae* covers 350–400 days at room temperature, and 250–300 days in the warmed cupboard. The cycle is so long that it cannot avoid the influence of the cold winter snap, and consequently at least one period is considerably lengthened.

(iv.) LONGEVITY. The longest periods observed were 937 days for a male and 897 days (i.e. about two and a-half years) for a female, both were kept at room temperature. The average life-span for both sexes is about 18 months. In the warmed cupboard, under conditions similar to continuous summer, cockroaches naturally died sooner. Table III. gives the information obtained from some colonies.

TABLE III.

LONGEVITY OF SOME P. AUSTRALASIAE ADULTS.

Colony Number.	Site.	Hatching to Death (Days).					
		Males (28).			Females (16).		
		Max.	Min.	Mean.	Max.	Min.	Mean.
2	Room	937	392	735 (7)	897	660	748 (3)
50	,, ...	751	427	590 (5)	643	381	502 (7)
17A	Cupboard.. ..	284		284 (1)	645		645 (1)
30A	,, ...	666		666 (1)	533		533 (1)
68	,, ...	713	470	557 (4)	427	359	393 (2)
141	,, ...	687	303	455 (9)	524		524 (1)
K	,, ...	653		653 (1)	476		476 (1)

Numbers in brackets indicate the number of individuals observed.

2. PERIPLANETA AMERICANA (Linnaeus, 1758).

(*a*) Description of Stages.

ADULT (Text–fig. 2 BI). Pale yellow pronotum with brown margins, wider posteriorly than anteriorly, and with two light brown maculae (often fused). Concolorous brown tegmina. Brown abdominal tergites and sternites, 7th tergite not backwardly produced. Light brown cerci. Small arolia present. The genital plates are shown in text–fig. 3.

Total length : ♂ 33–45 mm., ♀ 31–42 mm.

Tegmina length : ♂ 25–33 mm., ♀ 23–29 mm.

Pronotum width : ♂ 10–11·5 mm., ♀ 11–13 mm.

LARGE NYMPH (Text–fig. 2 BII). Almost uniformly brown, without the pale abdominal spots of the other two species. Pronotum with two slightly darker brown fused maculae, and a darker brown posterior margin. Abdominal tergites with darker posterior margins. Sternites brown, small arolia present.

NEWLY HATCHED NYMPH (Text–figs. 2 BIII and 4b). Greyish-brown body darkening slightly towards apex of abdomen. Posterior margins of tergites slightly darker in colour. Long almost translucent antennae. Slightly darker cerci. Legs translucent, arolia absent (Text–fig. 31). Body length, 4·5–5 mm.; antennae length, 7 mm.

EGG-CAPSULE (Text–fig. 2 BIV). Differs from that of *australasiae* in its smaller size and consequently in its more rounded appearance. Contains 16–18 eggs. Length, 8–9 mm.; depth, 5 mm.

(*b*) Life History.

(i.) INCUBATION PERIOD. Observations were made on about 70 egg-capsules. Those laid from October to February (i.e. during summer) hatched in about 7 weeks, those laid in March in 7 to 8 weeks, in April 10 to 11 weeks, in August in about 9 weeks, and in September in about 8 weeks. We have no records for eggs laid from May to July. The maximum period observed was 99 days. In the warmed cupboard the average incubation period was 50 days.

(ii.) DURATION OF NYMPHAL PERIOD. The rate of development varied greatly, and the recorded lag between the first and last adult was even greater than with *P. australasiae*, ranging from 3 to 11 months. In these observations the shortest period for complete development was 320 days for a male, and 287 days for a female at room temperature. The periods observed in some colonies of *americana* are given in Table IV.

TABLE IV.

Duration of Nymphal Development in P. americana.

Colony Number.	Site.	Date of Hatching.	Duration (in Days) from Hatching to Appearance of Adult.		
			Male.	Female.	Final.
33	Room	2 Aug.	477	505	813
73	„	26 Oct.	365	359	—
84	„	29 Oct.	320	287	—
98	„	9 Nov.	451	379	714
134	„	19 Nov.	335	337	452
29	Cupboard ..	20 July	325	274	395
340	„	24 Oct.	257	186	—
40	„	25 Oct.	192	134	331
91	„	5 Nov.	160	172	300

(iii.) EGG-LAYING CAPACITY. The preoviposition period varied a good deal with the season. In summer at room temperature and in the warmed cupboard egg-laying usually began about 2 weeks after the female's final moult if males were already present in the colony. The minimum period observed was 13 days.

In some colonies females appeared considerably sooner than males. If left thus unmated, they occasionally laid a few egg-capsules, which usually looked very abnormal and invariably failed to hatch.

Takahashi (1924) reported that *americana* can produce parthenogenetically a few, usually about three, egg capsules during life ; the young from these did not normally hatch, and those that did, failed to mature, However, Griffiths and Tauber (1942a) reported virgin females reproducing parthenogenetically. This phenomenon occurred in 9 capsules laid by 3 of a group of 25 unmated females. As many as 13 nymphs emerged from one capsule.

In an attempt to confirm these findings, 6 virgin females were kept in solitary confinement for periods ranging from 2 to 7 months. Of these, four laid no eggs, one laid one egg-capsule and another laid 2 egg-capsules. These were all soft, pale, obviously abnormal capsules, which failed to hatch.

Females usually carried their eggs for 1 or 2 days. Sometimes they glued them to the glass jar, but quite frequently they deposited them loosely in the sand or food, in contrast to *P. australasiae*, which almost always went to considerable trouble to fasten their eggs securely and to conceal them with debris.

In the warmed cupboard their reproductive capacity was at a maximum 2 to 3 months after reaching the adult stage. Females then produced as many as 7 capsules per month. Thereafter, the number gradually decreased, until, towards the end of life, they laid only 1 or 2 per month. At room temperature much the same thing occurred, but an early winter diapause was followed by renewed activity later in the year. For example a pair was mated in December, egg laying began in January, and the following monthly totals were recorded :—January (5), February (5), March (6), April (2), May (0), June (0), July (3), August (3), September (4), October (5), November (4), December (6), January (5), February (4), March (4), April (1).

It is interesting to note that in this, and in two other colonies, egg-laying was resumed in July—actually the coldest month. The egg-laying capacity of some individuals is set out in Table V.

TABLE V.

THE EGG-LAYING CAPACITY OF SOME P. AMERICANA FEMALES.

Colony Number.	Site.	Total Egg-Capsules.	Reproductive Period (Days).	Average Interval between Ovipositions (Days).
33	Room	57	448	8
73	,, ...	65	437	7
84	,, ...	20	232	12
134	,, ...	68	699	10
Average	,, ...	52	454	8·7
E	Cupboard	34	268	8
F	,, ...	37	246	7
Average	,, ...	36	257	7·5

(iv.) LONGEVITY. The longest period recorded was 1,502 days for a male, and 1217 days for a female kept at room temperature. The corresponding figures for the warmed cupboard were 1233 and 754 days respectively. Table VI. gives the periods observed in some *americana* colonies.

TABLE VI.

LONGEVITY OF SOME P. AMERICANA ADULTS.

Colony Number.	Site.	Hatching to Death (Days).					
		Males (22).			Females (15).		
		Max.	Min.	Mean.	Max.	Min.	Mean.
33	Room ..	1,449	1,023	1,251 (3)	984		984 (1)
73	,, ..	1,429	1,403	1,416 (2)	839		839 (1)
84	,, ..	1,194	942	1,068 (2)	693		693 (1)
98	,, ..	941	885	910 (3)	—	—	—
134	,, ..	1,502	1,329	1,415 (2)	1,217		1,217 (1)
29	Cupboard ..	1,233	841	1,004 (4)	645	533	607 (4)
40	,, ..	794	497	655 (4)	754	528	629 (5)
E	,, ..	1,033		1,033 (1)	469		469 (1)
F	,, ..	998		998 (1)	546		546 (1)

3. PERIPLANETA IGNOTA Shaw, 1925.

(*a*) DESCRIPTION OF STAGES.

ADULT (Text–fig. 2 CI). Light brown pronotum with pale yellow anchor-shaped marking, and darker lateral and posterior margins. Concolorous brown tegmina. Light brown abdominal tergites and sternites, darkening laterally and towards apex of abdomen ; 7th tergite backwardly produced ; dark brown cerci. The genital plates are shown in text–fig. 3.

Total length : ♂ 30–33 mm., ♀ 30–34 mm.

Tegmina length : ♂ 23–25 mm., ♀ 20–22 mm.

Pronotum width : ♂ 9–10 mm., ♀ 10–11 mm.

LARGE NYMPH (Text–fig. 2 CII). Brown pronotum with light median marking. Light brown mesonotum and metanotum with dark posterior margins. Dark brown abdominal tergites with pale lateral spots on 2nd and 6th segments and a pair of very small pale spots on 3rd segment. Light posterior margin on 7th tergite. Brown abdominal sternites darkening laterally.

NEWLY HATCHED NYMPH. (Text–figs. 2 CIII and 4c). Dark brown head. Dark antennae with basal segments pale and five apical ones white. Thoracic tergites brown, white transverse strip on mesonotum. Yellow abdominal tergites and sternites, darkening considerably laterally. Dark cerci. Pale legs with darker edges, arolia present (text–fig. 3m). Length of body, 4·5–5 mm.; length of antennae, 5 mm.

EGG-CAPSULE (Text–fig. 2 CIV). Very similar to that of *australasiae*, but each compartment slightly larger. Contains 22–24 eggs. Length, 12–13 mm.; depth, 5 mm.

(*b*) Life History.

This species is not present in Brisbane in as large numbers as *P. australasiae* and *P. americana*, but it is found occasionally in dwellings. Experiments were begun with a single female, which laid only one egg-capsule in captivity. Additional colonies were set up when the progeny of this female matured and commenced egg-laying. All were kept at room temperature.

(i.) INCUBATION PERIOD. During summer this varied from 49 to 61 days. Eggs laid in March required 11 weeks to hatch. Those laid in April 13 weeks.

(ii.) DURATION OF NYMPHAL PERIOD. All colonies developed during the summer months, the minimum periods observed were 110 days for a male and 126 days for a female. The lag between the appearance of the first and last adults varied from about 6 weeks to 7 months. Table VII. gives the information obtained from 4 colonies of *P. ignota*.

TABLE VII.

DURATION OF NYMPHAL DEVELOPMENT IN P. IGNOTA.

Colony Number.	Date Hatched.	Duration (in Days) from Hatching to Adult.		
		Male.	Female.	Final.
93	31 Dec.	110	248	327
368	28 Nov.	295	126	295
375	12 Dec.	289	257	301
388	23 Dec.	270	158	311

(iii.) EGG-LAYING CAPACITY. From two colonies containing groups of two and three females respectively, 59 and 89 egg-capsules were removed, so on an average one female could produce nearly 30 egg capsules. Unfortunately in each of these groups all the males died before the reproductive period of the females had ended. Females were observed to carry an egg-capsule for 1–2 days. They usually concealed their eggs in the sand, glueing them firmly to the bottom of the jar. In this habit and in the size of the egg-capsule they closely resembled *P. australasiae*. Females usually deposited their first egg capsule about 12 days after reaching adulthood. Thereafter they deposited them at intervals of about a week.

(iv.) LONGEVITY. The periods observed in the original colony were from 248 to 452 days, mean 390 days, for 7 males; and 515 to 732 days, mean 646 days, for 5 females.

B. OTHER DOMESTIC SPECIES.

Other domestic species of Blattidae occurring in Brisbane are *Blattella germanica* (Linn.) and *Supella supellectilium* (Serv.), (subfamily Pseudomopinae). *Nauphoeta cinerea* (Oliv.) (subfamily Panchlorinae) has been regarded as " semi-domestic", since it is found in outhouses and stores rather than in dwellings.

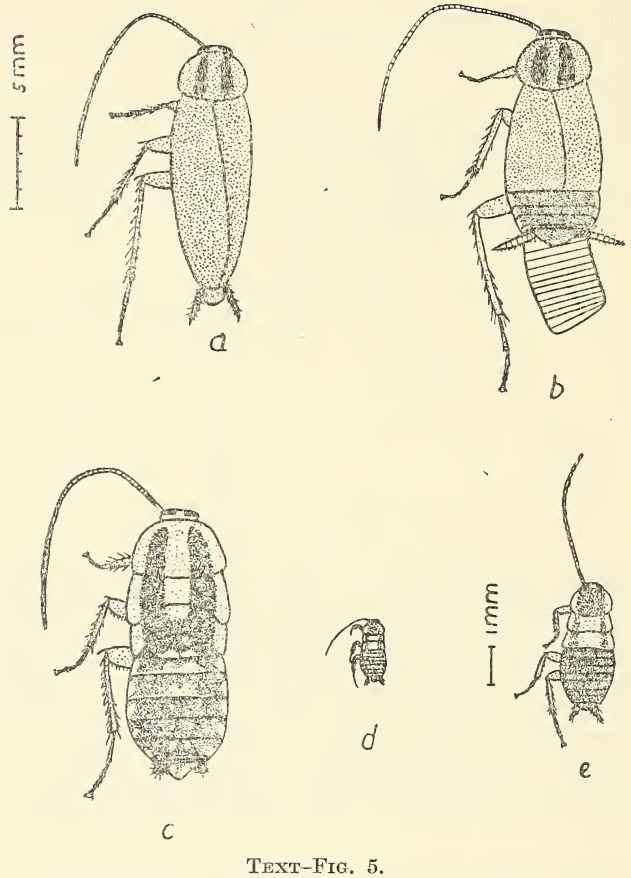
Froggatt (1906) noted that *B. germanica* was first recorded in Australia by Tepper (queried 1893, confirmed 1905).

B. germanica and *S. supellectilium* are small, light brown, very active species about half an inch long. The former has two very distinctive, longitudinal, black stripes on its pronotum ; the females carry their egg-capsules attached to their bodies until the young are ready to hatch. The

latter has a plain brown pronotum with transparent edges; the females deposit their egg capsules soon after they are produced. *N. cinerea* is a large, speckled, greyish-brown, sluggish species; the females are viviparous.

1. BLATTELLA GERMANICA (Linnaeus, 1767).

(*a*) Description of Stages.



Text-Fig. 5.

B. germanica. a, male adult; b, female adult with wings clipped to show egg-capsule; c, large nymph; d, and e, newly hatched nymph.

ADULT MALE (Text-fig. 5a). Light brown head with dark brown stripe on anterior edge of vertex, interocular width slightly less than interantennal, white ocelliform spots and small brown median dot on frons, slightly darker antennae. Light brown thoracic tergites with two longitudinal, parallel, black stripes. Light brown, concolorous tegmina; pale, almost colourless, wings with light brown costal and apical margins; tegmina and wings extending to tip of abdomen. First abdominal tergite rounded and darker than rest, 2nd to 6th tergite yellowish, with dark brown subapical markings laterally, and a pair of small transverse dark brown medial basal markings, 7th and 8th tergites light brown with glandular pockets,* 9th light brown with dark brown median marks; 2nd to 6th

* Wille (1921) reported that copulation is preceded by a lengthy love-play in which the female touches the dorsal glands of the male and then later licks them.

tergites with slight rounded backward projections, abdomen long and slender in shape. Some dark thoracic sternal plates ; light brown abdominal sternites. Light brown legs, coxae with slight black streaks, posterior metatarsus longer than other tarsal joints together ; light brown cerci considerably exceeding supra-anal lamina.

(*b*) FEMALE (Text–fig. 5b). Differs from the male in—

(i.) Genital plates (text–fig. 6). The emargination on the female supra-anal plate varies in its size, and even may be completely absent.

(ii.) General size. About the same length as the male, but abdomen is much broader, reaching, and often extending beyond, the tips of the tegmina (except when she is carrying an egg-capsule).

(iii.) Colour. (*a*) Generally much darker than the male ; (*b*) size and intensity of dark marking on frons greater than in males.

Total length :	♂ 14 mm., ♀ 14 mm.
Tegmina length :	♂ 10 mm., ♀ 10·5 mm.
Pronotum width :	♂ 3·5 mm., ♀ 4 mm.

LARGE NYMPH (Text–fig. 5c). Dark brown head, light brown vertex. Yellow thoracic tergites with two wide longitudinal, dark brown stripes, sometimes joining posteriorly on metanotum. Dark brown abdominal tergites with pale dots on lateral margins becoming smaller towards 7th tergite, and two median light brown dots on each tergite, most conspicuous on 2nd, 3rd, 4th and 7th. Brown abdominal sternites darkening towards apex and with pale lateral margins. Supra-anal plate mottled. Long dark brown cerci always standing upright. Pale yellow legs, coxae darker at base. Styles present in both sexes until the final nymphal moult, when those of the female disappear and those of the males remain. (There is great variation in the intensity of the light brown, median markings on the abdominal tergites of large nymphs).

NEWLY HATCHED NYMPH (Text–fig. 5d, e). Dark brown head and body. Thoracic tergites with transparent edges, 2nd and 3rd with wide yellow portion. Light brown, almost translucent legs with dark streak on coxae ; arolia present. Dark brown antennae with pale basal segments. Styles present in both sexes. Body length, 3 mm.; antennae length, 3·5 mm.

EGG-CAPSULE (Text–fig. 5b). Light brown, slightly darker at outermost end, and almost white at end attached to female's body ; roughly rectangular in shape ; usually contains 38–40 eggs. Length, 8 mm.; depth, 3 mm.

(*b*) LIFE HISTORY.

The egg capsule of *germanica* in its early period of formation was noticed protruding from the abdomen of the female with the serrated ridge in a dorsal position. When the capsule was almost fully extruded, it rotated, and finally rested with the ridge lateral on the right side, when looking at the female dorsally (*See* text–fig. 5b). It remained in this position until the young were ready to hatch. Several instances showed that the capsules would hatch after being removed from the female, only if they were well matured, and not even slightly damaged when removed. The abdomen of a female was always very contracted while she was carrying a capsule.

(i.) INCUBATION PERIOD. At room temperature egg-capsules hatching in midsummer were carried by a female for an average period of 24 days, while in winter the time was 42 days. In the cupboard the average was 28 days.

(ii.) DURATION OF NYMPHAL DEVELOPMENT. The period of nymphal development varied considerably according to the time of year when the young were born. Those hatching in summer, or kept in the warmed cupboard, developed very rapidly, reaching maturity in 7 to 10 weeks, whereas those hatching in winter required over 4 months. Males usually appeared first in a colony, but there was seldom a very great difference between the sexes. The lag between the first and last adult, which was such a marked feature in *Periplaneta* colonies seldom occurred, except in colonies reaching maturity late in summer, when those nymphs which were slowest in development were caught by the winter cold, and went on developing slowly for several months after the first adults had appeared (colony number 189). The results obtained in some colonies are set out in Table VIII.

TABLE VIII.

DURATION OF NYMPHAL DEVELOPMENT IN B. GERMANICA.

Colony Number.	Site.	Date of Hatching.	Duration (in Days) from Hatching to Appearance of Adult.		
			Male.	Female.	Final.
80	Room	3 Jan.	58	64	95
189	,, ...	9 Feb.	55	63	212
15	,, ...	21 May	139	147	161
25	,, ...	23 June	138	147	147
12	,, ...	2 July	98	107	114
41	,, ...	24 Sept.	61	61	76
126	,, ...	26 Nov.	53	56	69
132	,, ...	6 Dec.	49	49	65
24	Cupboard ..	15 June	76	80	101
27	,, ...	30 July	70	95	121
38	,, ...	30 Sept.	69	63	121
65	,, ...	29 Oct.	63	74	84

(iii.) NUMBER OF MOULTS. The determination of the number of moults is difficult and tedious owing to the habit of most cockroaches eating their exuviae. A special arrangement is necessary and it was attempted only for *B. germanica*.

One or at most two newly-hatched nymphs were placed in a test tube, fed on dried milk and yeast and watered by a 2 cc. ampoule full of water plugged in the mouth of the test tube. They were kept in the warmed cupboard. Daily examinations were made and the width of the head capsule was measured at frequent intervals after anaesthetising the insect with carbon dioxide. It was usually possible to predict when a nymph was about to moult by the stretched appearance of the body.

Of a large number of nymphs set up in this way, 29 became adults, 8 females and 21 males. Eleven males became adult after the sixth moult, but all the females and 10 of the males passed through seven moults before reaching the adult stage.

(iv.) EGG-LAYING CAPACITY. Females usually produced 4 or 5 egg-capsules.

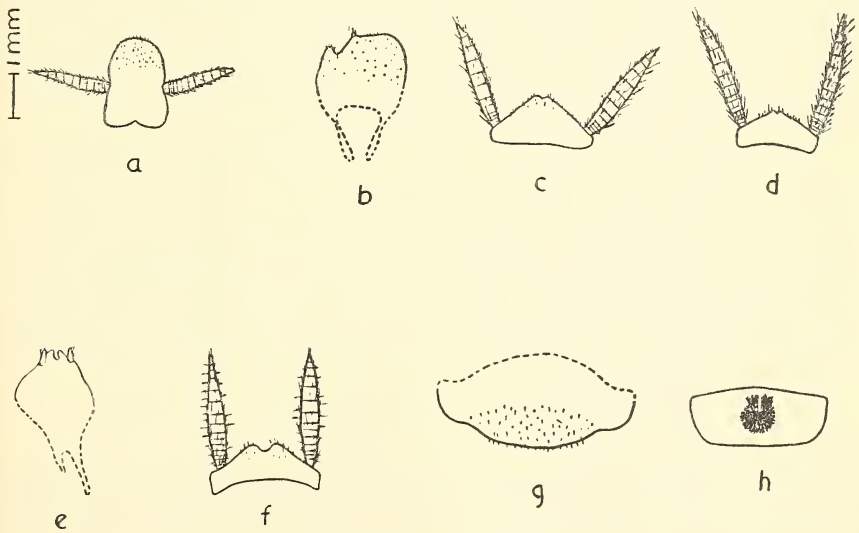
(v.) LONGEVITY. *B. germanica* is a relatively short-lived cockroach, living on an average about 9 or 10 months. Observations on 9 pairs which were kept at room temperature, gave the following figures :—Males, maximum 343, minimum 177, mean 260 days ; females, maximum 384, minimum 202, mean 297 days.

The egg-to-egg cycle was taken from the day a female was carrying a fully formed capsule until the day the first one of the progeny from that egg case was carrying a capsule. In seven colonies kept at room temperature the average duration of this cycle was 140 days. The maximum was 206 days for one beginning in the early winter and the minimum 88 in the early summer. In the controlled cupboard the cycle varied from 109 to 162 days.

2. SUPELLA SUPELLECTILIUM (Serville, 1839).

Dr. Eland Shaw recorded the presence of this insect in Queensland in 1924 when he wrote " *S. supellectilium* (Serv.) occurs as a domestic insect in company with the common *Blattella germanica* (Linn.) and seems capable of even more rapid multiplication than that species. Its spread over Australia generally is to be expected " (Shaw, 1924). In 1925 he wrote " . . . . . when *Supella supellectilium* (Serv.) invades places already occupied by *Blattella germanica* (L.), it tends to oust the latter." (Shaw, 1925, p. 205). This species is widespread in Brisbane at the present time, but usually it is found only in small numbers. We always had very great difficulty in establishing laboratory colonies, and *supellectilium* proved to be the most delicate of all the domestic species. It seems doubtful if it could oust *B. germanica* in Queensland.

The male is generally a pale yellowish colour with fully developed wings extending beyond the tip of its narrow, pale abdomen. The female is generally darker and much broader than the male ; her shorter wings do not reach the tip of the abdomen. The nymphs of this species can run fast and jump well.

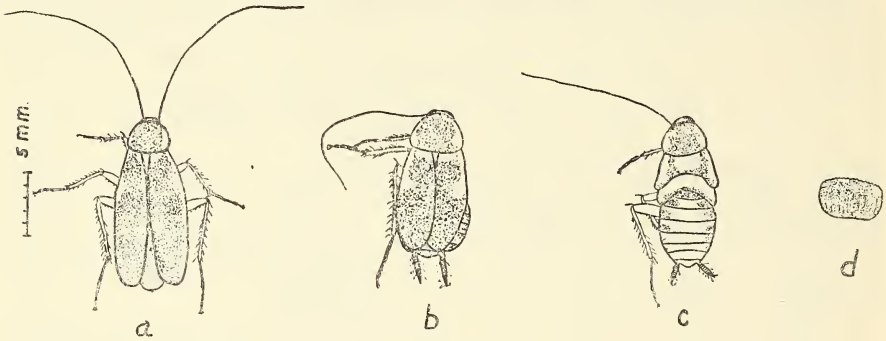


TEXT–FIG. 6.

Genital Plates. *B. germanica*. a, male supra-anal ; b, male subgenital ; c, female supra-anal. *S. supellectilium*. d, male supra-anal ; e, male subgenital ; f, female supra-anal ; g, female subgenital ; h, 7th tergite of male.

(*a*) Description of Stages.

ADULT (*a*) MALE (Text–fig. 7a). Yellow to yellowish-brown head (sometimes with rather orange vertex), white ocelliform spots, brown dot below each antennal socket, interocular width less than interantennal, dark brown antennae. Pronotum brown over body with transparent anterior and lateral edges, very narrow, dark margin all round and narrow yellow median stripe. Pale yellowish brown tegmina with transparent humeral area, slight paleness in base of dividing vein with effect of a darker brown band just below; wings colourless with slight brown marking at apex; tegmina and wings both extending beyond tip of abdomen. First five abdominal tergites colourless, remainder yellow, 7th with characteristic brown impressed area (text–fig. 6h); postero-lateral angles of tergites not backwardly produced. Supra-anal plate with slight emargination (text–fig. 6d). Some dark thoracic sternites, abdominal sternites



TEXT–FIG. 7.

S. supellectilium. a, male adult; b, female adult; c, large nymph; d, egg capsule.

darkening to orange at apex; general shape of abdomen slender. Subgenital plate narrow, roughly triangular with lobe-like styles (text–fig. 6a). Pale yellowish legs darkening to orange tarsi, posterior metatarsus longer than other tarsal joints together, pulvilli small and inconspicuous, arolia present, tarsal claws symmetrical. Pale yellow cerci darkening towards tip, extending considerably beyond supra-anal lamina.

(*b*) FEMALE (Text–fig. 7b). Short, brown tegmina with transparent humeral margin with two incomplete transverse colourless bands near base; tegmina and wings covering about three-fifths of abdomen. Abdominal tergites yellow with brown markings laterally on third to fifth segments, sixth brown, remainder with centre brown and lateral portions pale. Some dark thoracic sternal plates, abdominal sternites orange, darkening towards apex of abdomen. Supra-anal plate with small emargination (text–fig. 6f). Subgenital plate orange, ample, rounded (text–fig. 6g).

Total length:	♂	and	♀ 12–13 mm.
Tegmina length:	♂ 11–12 mm.,		♀ 8–9 mm.
Pronotum width:	♂	and	♀ 3·5–4·5 mm.

LARGE NYMPH (Text–fig. 7c). Dark brown head, usually lighter above antennal sockets, antennae with yellowish-brown base, darkening to black tips. Pronotum dark brown over body with transparent anterior and lateral edges and some variable light marking in centre; very pale yellow mesonotum with H-shaped dark area; pale yellow metanotum with dark posterior margin. First abdominal tergite very dark brown, others pale

yellow (2nd to 5th with dark brown, lateral marks). Some dark thoracic sternal plates; yellowish abdominal sternites. Supra-anal plate with small lateral dark marks, rounded triangular shape, no emargination. Very pale yellow coxae and femora, more orange tibiae and tarsi. Cerci pale at base, dark at apex.

NEWLY HATCHED NYMPH. General colouration light greyish-brown. Pronotum with pale lateral margins, mesanotum with central third white, sides and posterior margins light brown, metanotum mainly white with a light greyish-brown area on each side near anterior margin and along posterior margin. Tergites light greyish-brown, ventral surface pale. Legs very pale yellow almost translucent. Antennae similar in colour to body except for the third segment which is paler. Styles present in both sexes. Arolia present. Length, 2·6 mm.; antennae, 4 mm.

EGG-CAPSULE (Text–fig. 7d). Light brown, concolorous. As eggs mature a definite medio-lateral green tinge develops. Usually containing 18 eggs, range 16–20. Length, 5 mm.; depth, 3 mm.

(*b*) LIFE HISTORY.

S. supellectilium appeared very fond of the gum on the backs of labels and consequently some were included in its regular diet.

(i.) INCUBATION PERIOD. The incubation period varied from 63 to 156 days. Eggs laid in July did not hatch until October; August eggs hatched in November (about 90 days); those laid in November hatched in 63 days. Eggs laid in March at the end of summer did not hatch until July and August (maximum period observed 156 days). In the warmed cupboard they hatched in 7 weeks.

(ii.) DURATION OF NYMPHAL DEVELOPMENT. The period of nymphal development varied considerably with the season; however, even in mid-summer its development was slower than that of *B. germanica*. The minimum period observed was 90 days for a male and 98 days for a female, developing at room temperature in mid-summer, the maximum period observed from hatching to the appearance of the first adults was 223 days in a colony hatching in late summer. The results obtained from some colonies are set out in Table IX.

TABLE IX.

DURATION OF NYMPHAL DEVELOPMENT OF S. SUPELLECTILIUM.

Colony Number.	Site.	Date of Hatching.	Duration (in Days) from Hatching to Appearance of Adult.		
			Male.	Female.	Final.
163	Room	5 Jan.	161	236	355
239	,, ...	11 Mar.	223	223	241
92	,, ...	5 Nov.	90	98	117
225	,, ...	22 Nov.	217	217	240
37	Cupboard ..	1 Sept.	96	114	138
42	,, ...	14 Sept.	121	153	153
52	,, ...	23 Sept.	124	148	249
59	,, ...	2 Oct.	150	136	255
90	,, ...	4 Nov.	117	111	182

(iii.) EGG-LAYING CAPACITY. The preoviposition period varied from 8 to 9 days in the warmed cupboard to 63 days for a pair mated at the beginning of winter at room temperature. Females usually carried their egg-capsules for 1 or 2 days, but occasionally were observed to carry them for longer periods up to 8 days. The capsules were produced and carried with the ridge dorsal. Females laid from 6 to 25 capsules, the average for 7 pairs being 14. Isolated females laid eggs at intervals ranging from 3 to 13 days, the most frequently observed interval being 7 days.

In several instances unmated *supellectilium* females produced either apparently normal egg cases that failed to hatch, or a mass of whitish eggs not covered at all by a capsule. The latter soon dried and shrivelled on coming in contact with the air.

(iv.) LONGEVITY. *S. supellectilium* has a rather longer life-span than *B. germanica*, the average period being a little greater than one year. It must be remembered that it was the least adaptable of the domestic species. Many nymphs died before reaching maturity and it is possible that under more favourable conditions, it would live longer than in our laboratory colonies. The longevity of some adults is set out in Table X.

TABLE X.

THE LONGEVITY OF SOME S. SUPELLECTILIUM ADULTS.

Sex.	Place Reared.	Longevity (Days).		
		Max.	Min.	Mean.
Male ..	Room	667	259	490 (6)
	Cupboard	397	173	272 (7)
Female ..	Room	538	154	385 (6)
	Cupboard	240	207	228 (3)

Figures in brackets indicate number of individuals.

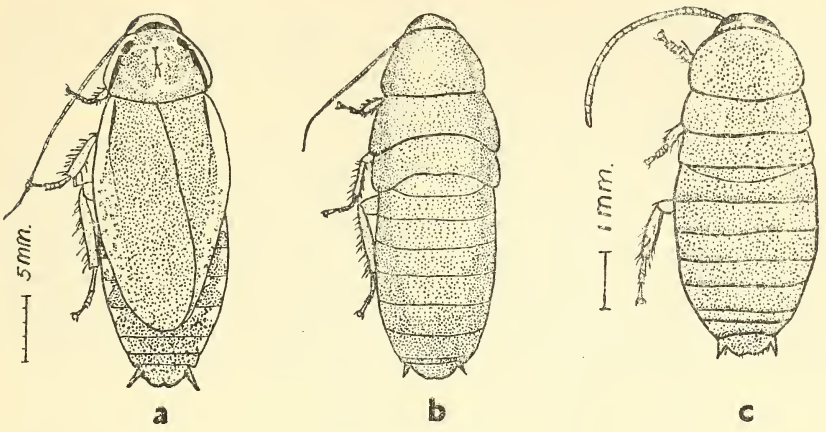
3. NAUPHOETA CINEREA (Olivier, 1789).

This is a "semi-domestic" species. Although adults have been found in dwellings, there have been no reports of its breeding there. Usually this species is associated with grain stores and fowl-feeding pens. No record of the life history of this species was found in Australian literature. It was first recorded in Australia by Shaw (1918), having been taken at various localities between Brisbane and Cairns.

Both sexes have fully developed wings, which fall just short of the tip of the abdomen. They have short, stout legs, and cannot run as fast as the domestic species. They have a more scuttling movement. The male subgenital plate bears a pair of unsegmented styles. The female's body is larger than that of the male.

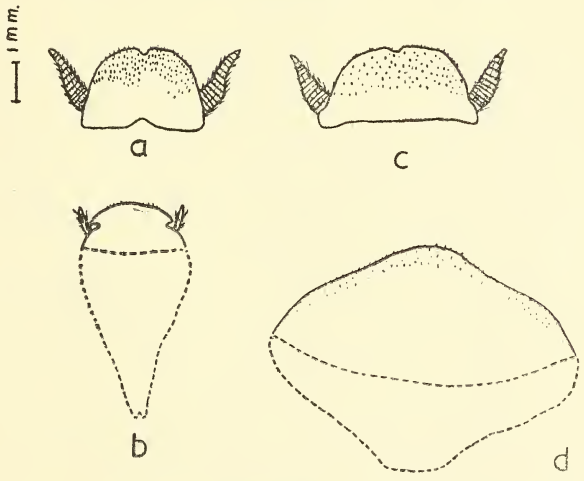
(*a*) DESCRIPTION OF STAGES.

ADULT (Text–fig. 8). Fawn head with dark brown interocular band, light interantennal band, interocular width less than interantennal, white ocelliform spots, pale palps. Medium brown pronotum with fawn lateral margins and symmetrical fawn picturing, dark brown, longitudinal stripe on lateral edge of pronotal disc. Medium brown tegmina speckled with white, translucent fawn costal area; colourless wings with medium brown veins; tegmina and wings reaching at least to 7th tergite. Abdominal tergites medium brown with white markings; 1st to 7th not backwardly



TEXT-FIG. 8.

N. cinerea. a, male adult; b, large nymph; c, newly hatched nymph (mounted specimen).



TEXT-FIG. 9.

N. cinerea. Genital plates, a, male supra-anal; b, male subgenital; c, female supra-anal; d, female subgenital.

produced, 8th only slightly so, abdominal sternites medium brown with a few white markings, darkening towards apex. Pale legs, femora unarmed beneath, short tibiae, large pulvilli, large arolia, tarsal claws symmetrical. Supra-anal lamina rounded, one median notch on posterior margin (text-fig. 9a male, and 9c female); pale cerci only slightly exceeding this lamina. Male subgenital plate with a pair of unsegmented styles (text-fig. 9b); female subgenital plate ample, rounded (text-fig. 9d).

Total length:	♂ 27–29 mm.,	♀ 29–31 mm.
Tegmina length:	♂ 16–17 mm.,	♀ 18–20 mm.
Pronotum width:	♂ 7–8·5 mm.,	♀ 9–10 mm.

LARGE NYMPH (Text-fig. 8b). Medium brown, shiny head and body. White ocelliform spots, eyes slightly reduced, interocular width about equal to interantennal, brown antennae, paler clypeus. Thoracic tergites with very dark brown lateral margins; abdominal tergites with dark lateral

and posterior margins, generally darkening towards apex of abdomen; only 8th slightly backwardly produced. Some dark thoracic sternal plates; anterior abdominal sternites with median yellow tinge. Lighter brown legs with dark spines on short tibiae; large arolia. Medium brown cerci not extending beyond supra-anal lamina.

NEWLY HATCHED NYMPH (Text–fig. 8c). Head with greyish-brown vertex, becoming paler towards the clypeus, palps translucent, eyes reduced, interocular space greater than inter-antennal space, slightly darker antennae. Greyish-brown body; abdominal tergites with slightly darker posterior margins; ventral surface of abdomen grey, darkening laterally and towards its apex. Supra-anal plate produced, one median notch; short cerci not projecting beyond this plate. Styles present in both sexes. Light brown, almost translucent legs, tarsal claws symmetrical, large arolia. Body length, 5 mm.; pronotum width, 2 mm.

(*b*) LIFE HISTORY.

In the laboratory this species was found to be particularly fond of cracked maize, consequently this formed the main part of its diet, supplemented by dried milk, dried yeast and fresh apple. It will eat its own exuviae and dead (sometimes even before specimens are dead).

Mating was never observed in this species, although sometimes the males would be seen running around the jars with their backs arched and their wings standing upright. It is presumed that mating occurs at night. The females are viviparous. The eggs are formed side by side in a double row into an egg mass similar to that of other species. *N. cinerea* females retain their egg mass, covered by a soft, transparent membrane within their bodies until the young are ready to hatch. The plane of the egg mass is parallel to that of the female's body.

(i.) INCUBATION PERIOD. As mating was not observed, and no egg-capsule is produced, the length of the period of gestation was never observed accurately. The period of gestation covers the interval from the pairing of a male and a female to the production of young. Possible periods of gestation were calculated from the appearance of a newly moulted adult female in a colony, where one or more adult males were already present, to the production of the first batch of young. These periods varied from 50 to 196 days, mean 105 days, at room temperature, and from 44 to 102 days, mean 64 days, in the warmed cupboard.

(ii.) EGG-LAYING CAPACITY. One female can produce as many as 4 "egg masses" each containing 30–40 eggs, usually at intervals of about 2 months. Often an old female produced a "premature" mass of creamish eggs, which did not hatch. On coming in contact with the air, it immediately hardened and shrivelled.

(iii.) DURATION OF NYMPHAL DEVELOPMENT. The rate of nymphal development was surprisingly rapid for such a large, sluggish insect. The shortest period was 107 days in a colony set up in early summer. Males usually appeared first. The results observed in some colonies are set out in Table XI.

(iv.) LONGEVITY. *N. cinerea* is a long-lived species. The maximum life-span recorded was 1,185 days for a male, and 1,026 days for a female. Table XII gives the periods observed for some adults.

The "egg-to-egg" cycle, measured from the production of one batch of young until the latter produced their first young, varied from 295 to 481 days, mean 372 days at room temperature (6 observations); and 182 to 246 days, mean 221 days in the warmed cupboard (5 observations).

TABLE XI.

Duration of Nymphal Development of N. cinerea.

Colony Number.	Site.	Date of Birth.	Birth to Appearance of Adult (Days).		
			Male.	Female.	Final.
161	Room	10 Jan.	241	254	336
190	,, ...	7 Feb.	211	226	322
4	,, ...	1 Mar.	279	322	332
31	,, ...	30 July	215	285	285
109	,, ...	24 Nov.	119	141	407
107	,, ...	25 Nov.	161	279	—
124	,, ...	30 Nov.	107	156	274
149	,, ...	20 Dec.	213	338	470
22	Cupboard ..	21 Jan.	112*		209
3A	,, ...	2 Feb.	187	191	342
3	,, ...	6 Apr.	189	202	261
108	,, ...	19 Nov.	136	146	—
136	,, ...	8 Dec.	139	—	243

* Sex not recorded.

TABLE XII.

The Longevity of some N. cinerea Adults.

Sex.	Place Reared.	Longevity (Days).		
		Max.	Min.	Mean.
Male ..	Room	1,185	324	550 (10)
	Cupboard	646	383	473 (3)
Female ..	Room	1,026	381	803 (3)
	Cupboard	619	296	398 (10)

DISCUSSION.

In the accessible literature are descriptions of the biology and life histories of various cosmopolitan domestic species of Blattidae. *Blatta orientalis* Linn., *Periplaneta americana* (Linn.), *P. australasiae* (Fabr.), *Blatella germanica* (Linn.), and *Supella supellectilium* (Serv.). All these species, with the exception of *B. orientalis**, are common in Brisbane at present.

It is interesting to notice that the species which have become domestic pests in Queensland are all cosmopolitan and have been introduced. The possible exception is *Periplaneta australasiae* (Fabr.). The origin of this insect is not at all clear. Froggatt (1906) recorded that it was then rare near Sydney, N.S.W., and regarded it as remarkable that a species not common in its own country had become a serious domestic pest when introduced into America. There seems no doubt that it was widespread in America at the beginning of this century. Marlatt (1902) reported that it was the most abundant and troublesome species in Florida. Shaw (1925) considered that Fabricius used *australasiae* to mean "of Southern Asia," since the term Australasia as applied to Australia and New Zealand was not in use when he described the insect in 1775. Probably it is also an

* The specimens of *Blatta orientalis* in the Eland Shaw collection in the Queensland Museum were obtained at Kadina, S.A.

introduced pest. *P. ignota* Shaw was first described in 1925 from specimens collected in Queensland, Shaw (1925). It is probably an endemic species, but it is not abundant enough to be regarded as a serious pest.

P. americana was studied by Haber (1920) in U.S.A., Takahashi (1924) in Formosa, Fischer (1928) in Germany, Nigam (1933) in India, Klein (1933) in Palestine, and Gould and Deay (1938), Rau (1940) and Griffiths and Tauber (1942) all in U.S.A. Studies of *B. orientalis* were carried out by Miall and Denny (1885) in England, Rau (1924) in U.S.A., Zabinski (1929) in Europe and Qadri (1938) in England. The development of *B. germanica* was observed by Wille (1921) in Germany, and Woodruff (1938) in U.S.A. *S. supellectilium* was studied by Cottam (1922) in Khartoum, and Back (1937) in U.S.A.

The works of Marlatt (1915), Haber (1919), and Laing (1921) included the above species except *S. supellectilium*, while the later reports of Gould and Deay (1938 to 1940), Gould (1941) and Metcalf and Flint (1939) covered them all, and included some others. Laing carried out his studies in Britain, and the others in America.

When allowance is made for climatic differences, our findings agree fairly well with those of the authors quoted. Gould and Deay (1938) found the incubation period of *P. americana* to vary from 35 to 100 days, the average for over 400 egg-capsules being 55 days. They found an average preoviposition period of 13·4 days, and that one female could produce 59 eggs at an average interval of 5·9 days. The nymphal period varied from 285 to 616 days, average 409 days at a temperature range of 68° to 82° F., with relative humidity ranging from 27 to 61%. These authors noted that the males of *P. americana* were usually longer in reaching the adult stage than the females. This also occurred in our colonies. With *P. ignota* (in the limited number of colonies observed) and with *P. australasiae* the reverse was usually true. Gould and Deay (1938) record a maximum life span for *P. americana* of 913 days, but Griffiths and Tauber (1942) report that the life-span may exceed 1,200 days. A maximum of 1,502 days is recorded here.

B. germanica has probably been studied more intensively than any other species. Gould (1941) records an egg-laying capacity of 5 capsules per female, a figure which agrees well with my results. Laing (1921), recorded a maximum of 7 egg-capsules per female. However, it seems clear that this species lays relatively few egg-capsules; its abundance is due to its rapid development, to the large number of nymphs (38–40) produced from each capsule, and to the greater protection from both enemies and desiccation afforded to the eggs by being carried by the female during incubation.

S. supellectilium produces a small egg-capsule usually containing only 15–18 nymphs. The incubation period is a relatively long one and nymphal development is slow. These factors probably contribute to its scarcity in comparison with *B. germanica*. Gould and Deay (1940) gave a good account of its life history in America. They found an incubation period of 90 days at 73°F. and 49 days at 82°F. Nymphal development required 161 days at room temperature, and 92 days at 84°F. Females produced about 15 egg-capsules containing about 13 nymphs. The minimum incubation period recorded by Cottam (1922) working in Khartoum was 33 days.

Illingworth (1941) studied *N. cinerea* and recorded its viviparous nature, finding 28–40 young produced at each birth. He also noted its association with poultry food sheds in Honolulu.

SUMMARY.

The domestic species of Blattidae occurring in Brisbane are *Periplaneta australasiae* (Fabr.), *P. americana* (Linn.), *P. ignota* Shaw, *Blattella germanica* (Linn.), and *Supella supellectilium* (Serv.). *Nauphoeta cinerea* (Oliv.) is a "semi-domestic." The *Periplanetas* deposit their capsules within a day or two of formation. *S. supellectilium* carries them for 1 to 8 days, and *B. germanica* carries them until the eggs are ready to hatch. *N. cinerea* is viviparous.

The maximum number of ovipositions recorded was :—*P. australasiae* (31), *P. americana* (68), *P. ignota* (30), *B. germanica* (5), *S. supellectilium* (25) and *N. cinerea* (4).

The usual numbers of eggs in a capsule were :—*P. australasiae* (26), *P. americana* (16), *P. ignota* (24), *B. germanica* (40), *S. supellectilium* (18) and *N. cinerea* (40).

The rate of development of all stages was greatly influenced by temperature, but there was also considerable variation in the rate of nymphal development among siblings.

The incubation periods varied from 39 to 160 days for *P. australasiae* ; 39 to 99 days for *P. americana* ; 49 to 91 days for *P. ignota* ; 24 to 42 days for *B. germanica* ; 63 to 156 days for *S. supellectilium*.

The nymphal periods varied as follows :—*P. australasiae* 134–596 days, *P. americana* 134–813 days, *P. ignota* 110–327 days, *B. germanica* 49–212 days, *S. supellectilium* 90–355 days, *N. cinerea* 107–470 days.

The maximum life-spans recorded were :—*P. australasiae* 937 days, *P. americana* 1,502 days, *P. ignota* 732 days, *B. germanica* 384 days, *S. supellectilium* 667 days, *N. cinerea* 1,185 days.

The egg-to-egg cycles of the *Periplanetas* and *N. cinerea* cover about a whole year. Two to three generations of *B. germanica* could be bred each year and about two of *S. supellectilium*.

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